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APPLICATION NOTE

AP-91

Using the 8049 as an 80 Column Printer Controller

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Contents

USING THE 8049 AS AN 80 COLUMN PRINTER CONTROLLER

I. INTRODUCTION

This Application Note details using INTEL's 8049 microcomputer as a dot matrix printer controller. Previous INTEL Application notes, (e.g. AP-27 and AP-54) described using intelligent processors and peripherals to control single printer mechanisms. This Application note expands upon the theme established in these prior notes and extends the concept to include a complete bi-directional 80 column printer using a single line buffer. For convenience this application note is divided into six sections:

1. INTRODUCTION
2. PRINT MECHANISM DESCRIPTION
3. INTERFACE CIRCUITRY
4. SOFTWARE
5. CONCLUSION
6. APPENDIX

Over the last few years 80 column output devices have become somewhat of a defacto output standard for business and some data processing applications. It should be mentioned that by no means is the 80 column format a "new" standard. 80 column computer cards have been around for more than 20 years and perhaps the existence of these cards in the early days of computers is why the 80 column format is a standard today.

Many CRT terminals use the 80 by N format and to complement this a number of printers use this same format. One reason, aside from those historic in nature, for the 80 column standard is that 80 columns of 12 pitch text on standard typewritten 8.5 inch by 11 inch paper completely fills up an entire line and allow ample room for margins. So, the 80 column format is an aesthetically convenient format.

Printers are usually divided into either impact or non-impact and a character or line oriented device. Impact printers actually use some type of "striker" to place ink on the paper. More often than not the ink is contained on a ribbon which is placed between the striker and the paper. Non-impact printers use some means other than direct pressure to place the characters on the paper. This type of printer is very fast because there is very little mechanical motion associated with placing the characters on the paper. However, because the paper is required to be treated with a special substance, it is not as convenient as an impact printer.

Character printers are capable of printing one character at a time. (Any standard home typewriter is in effect a character printer.) Line printers must print an entire line at a time. Line printers are usually quite a bit faster than character printers, but they usually don't offer the print quality of character printers.

In recent years, the "computer boom" has caused the price of printers to tumble markedly. High volume production, competition, and the tremendous demand for reliable print mechanisms have all contributed to the decrease in price. Because of their simplicity, line printer mechanisms have decreased in price faster than other mechanisms. Therefore, when high quality print is not needed, a line printer is a very attractive choice.

This application note describes how to control an 80 column impact-line printer with an 8049/8039. The complete software listing is included in the appendix. The 8049 is the high-performance member of the MCS-48TM microcontroller family. The Processor has all of the features of the 8048 plus twice the amount of program and data memory and an 11MHz clock speed. For details about the 8049, please refer to the MCS-48 user's manual.

II. PRINT MECHANISM DESCRIPTION

The model 820 printer is available from C. ITOH ELECTRONICS (5301 BEETHOVEN STREET, LOS ANGELES, CA 90066). This inexpensive and simple printer is ideal for applications requiring 80 columns of dot matrix alpha-numeric information.

The model 820 printer is comprised of three basic sub-assemblies; the chassis or frame, the paper feed mechanism, and the print head. The diagram in Figure 2.1 gives the physical dimensions of the basic print mechanism. The basic chassis for the printer is constructed out of four sheet metal stampings. These stampings are screwed together to form a sturdy base on which all other components of the printer are mounted.

The paper feed mechanism consists of a toothed wheel, a solenoid, a tension spring, and a "catcher." When the solenoid is activated, the arm of the solenoid pulls against the spring and drags over the toothed wheel. When the solenoid is released, its arm is pulled by the spring, but this time the arm grabs a tooth on the wheel and pulls the wheel forward which advances the paper. A "catcher," which is merely a piece of plastic held against the toothed wheel, is added to assure that the paper is advanced only one "tooth" position each time the solenoid is activated.

The print head is comprised of seven solenoids which are mounted in a common housing. The solenoids are physically mounted in a circle, but their hammers are positioned linearly along the vertical axis. These seven vertically positioned hammers are the strikers that actually do the printing.

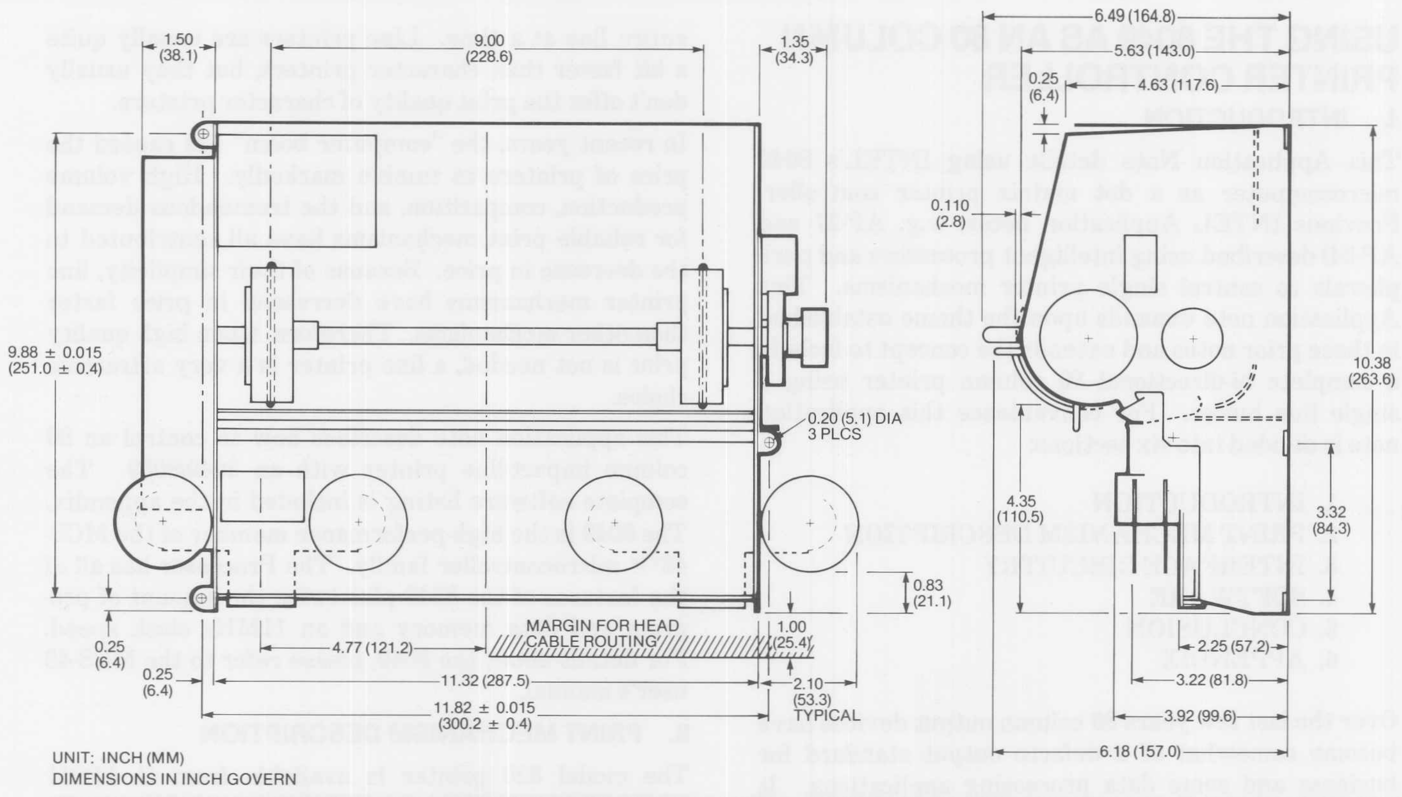


Figure 2.1 Physical Dimensions of C. ITOH Model 820 Printer

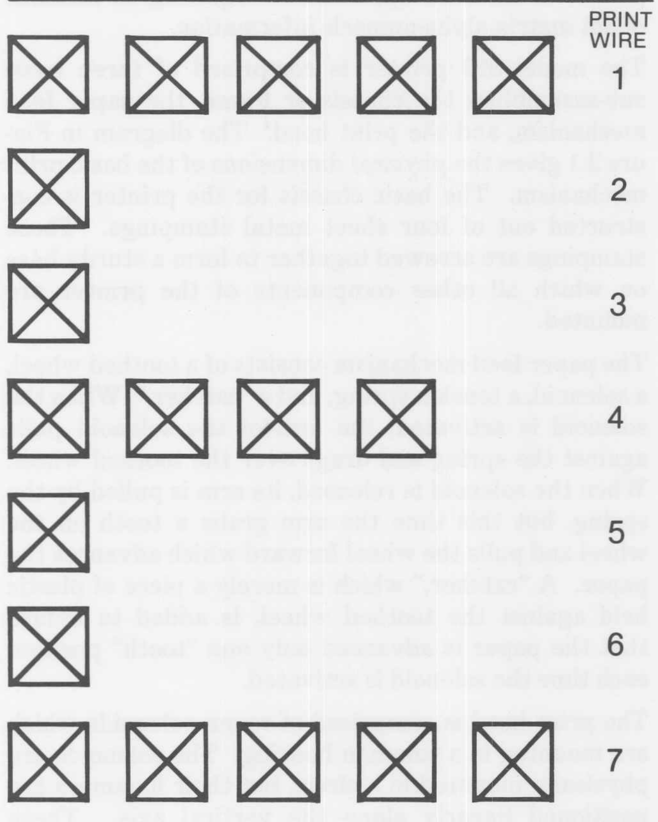


Figure 2.2 "Formation" of a Character by a Dot Matrix Printer

A motor, mounted toward the back of the print mechanism, drives a rubber toothed belt which turns a roller guide. A motor turns a guide that moves the print head from right to left and left to right. By properly timing the current flow through the solenoids while the print head is moving across the paper, characters can be formed. Figure 2.2 illustrates how the dot matrix printer "forms" its characters.

The timing pulses for the print head mechanism are generated by an opto-electronic sensor. This sensor, located on the left side plate of the printer, informs the print controller when to apply current to the print head mechanism. This "on-board timing wheel" assures that all characters will be properly spaced and that they will all be "in-line" in a vertical sense.

The print mechanism is also equipped with two additional sensors. These are the left home position sensor, located near the left front of the mechanism, and the right home position sensor, located near the right front of the print mechanism. These sensors simply tell the controller when the print head is in either the left or right home position. A complete timing chart for the printer is shown in Figure 2.3.

III. INTERFACE CIRCUITRY

The manual supplied with the printer recommends some specific interface circuitry. For the most part the circuitry used in this Application Note followed these suggestions. The circuitry needed to drive the print head solenoid is shown in Figure 3.1. This same

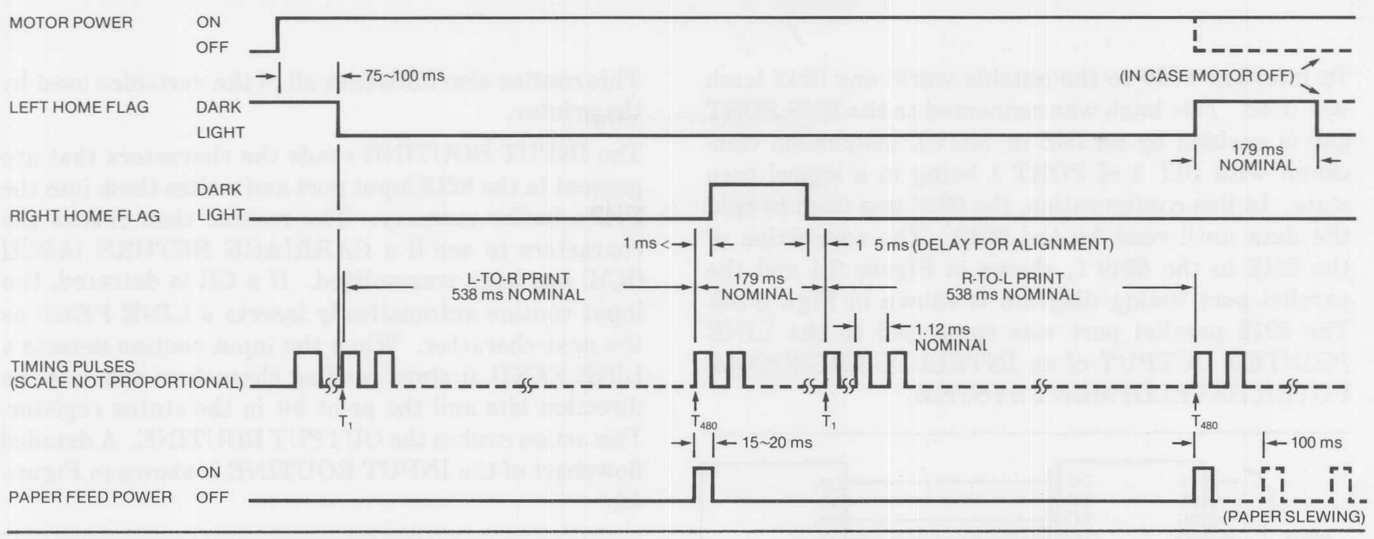


Figure 2.3 Timing Diagram of C. ITOH Model 820 Printer

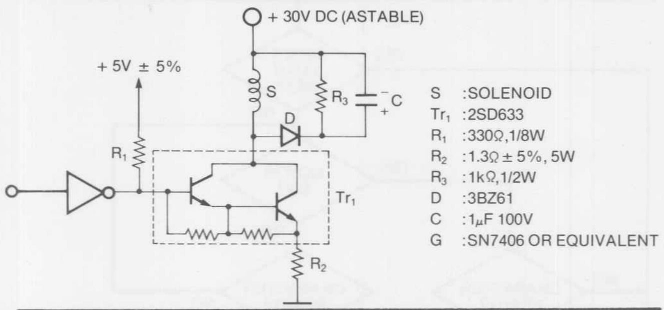


Figure 3.1 Solenoid Drive Circuit (Eliminate R2 for Line Feed Solenoid)

circuit is used to drive the line feed solenoid except that the current limiting resistor R2 is eliminated. This resistor is not needed because the line feed solenoid is physically much larger than the print head solenoids and can tolerate much higher levels of current.

The print head drivers are connected to an 8212 latch. The latch is interfaced to the BUS PORT on the 8049 and is enabled whenever the WR pin and the BIT 4 of PORT 1 are coincidentally low. The line feed driver is connected to PORT 1 BIT 1 of the 8049.

Note that the driver is simply a Darlington transistor that is driven by an open collector TTL gate. Resistor R2 is the current limiting resistor and diode D, capacitor C, and resistor R3 are used to "dampen" the inductive spike that occurs when driving solenoid S. This circuit is repeated for each of the seven solenoids in the print head. It should be mentioned that, although the type of Darlington transistor needed to drive the print head is not critical, a collector current rating of at least 5 amps and a breakdown voltage (Vceo) of at least 100 volts is needed. Transistors that do not meet these requirements will be damaged by the inductive kickback of the solenoids.

As mentioned in Section 2, the printer provides some sensor interface signals that are derived via three optoelectronic sensors. These signals must be amplified and converted to TTL levels in order to interface to the controller. This conversion is accomplished with a simple voltage comparator. Figure 3.2 is a schematic of the sensor interface circuitry. Note that hysterisis is employed on the voltage comparators. This eliminates "false" sensing.

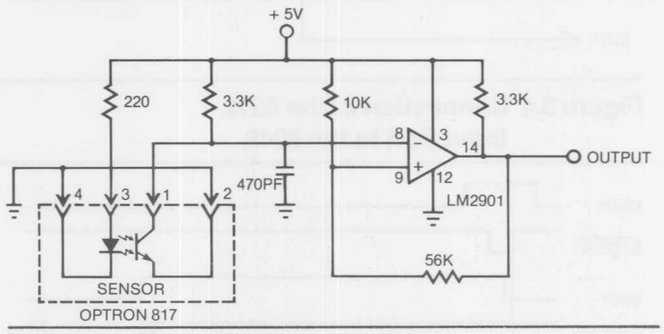


Figure 3.2 Example of Sensor Circuit

Motor control is accomplished by using a Monsanto MCS-6200 optically-coupled TRIAC. This part is ideal in this kind of application because it provides a simple means of controlling a line-operated motor without sacrificing the isolation needed for safe and reliable operation. Figure 3.3 is a schematic of the motor driving circuit.

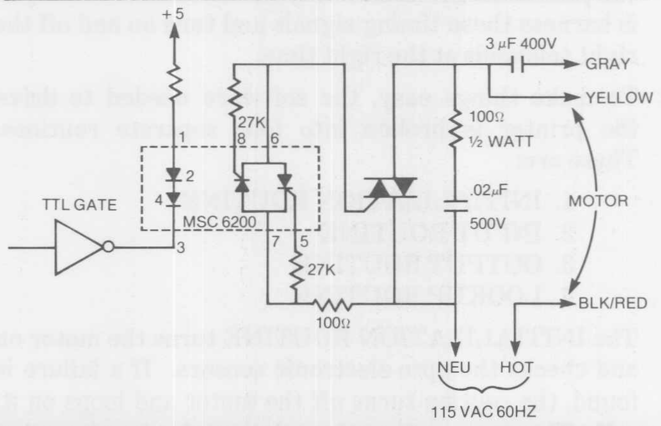


Figure 3.3 Motor Driving Circuit

To interface 8049 to the outside world one 8212 latch was used. This latch was connected to the BUS PORT and is enabled by an INS or MOVX instruction coincident with BIT 4 of PORT 1 being in a logical zero state. In this configuration, the 8212 was used to hold the data until read by the 8049. The connection of the 8212 to the 8049 is shown in Figure 3.4 and the parallel port timing diagram is shown in Figure 3.5. The 8212 parallel port was connected to the LINE PRINTER OUTPUT of an INTELLEC MICROCOMPUTER DEVELOPMENT SYSTEM.

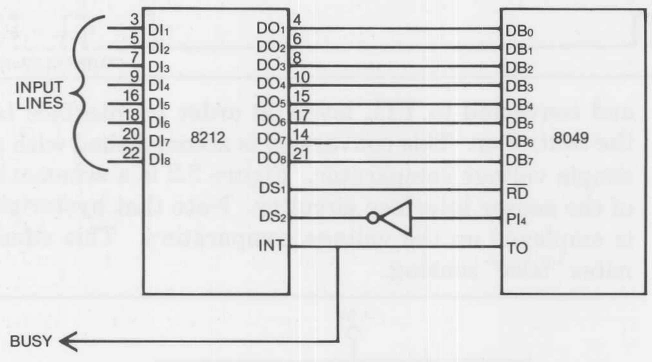


Figure 3.4 Connection of the 8212 Input Port to the 8049

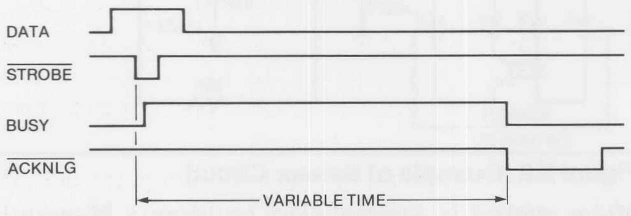


Figure 3.5 Parallel Port Timing

IV. SOFTWARE

As mentioned in Section 2, the bulk of the timing needed to control the printer is actually generated by the printer itself. Therefore, all the software must do is harness these timing signals and turn on and off the right solenoids at the right time.

To make things easy, the software needed to drive the printer is broken into four separate routines. These are:

1. INITIALIZATION ROUTINE
2. INPUT ROUTINE
3. OUTPUT ROUTINE
4. LOOKUP ROUTINE

The INITIALIZATION ROUTINE turns the motor on and checks the opto-electronic sensors. If a failure is found, the routine turns off the motor and loops on itself. This insures that the print mechanism is cycled properly before characters are accepted for printing. This routine also initializes all of the variables used by the printer.

The INPUT ROUTINE reads the characters that are present in the 8212 input port and writes them into the 8049's buffer memory. The routine then checks the characters to see if a CARRIAGE RETURN (ASCII OCH) has been transmitted. If a CR is detected, the input routine automatically inserts a LINE FEED as the next character. When the input routine detects a LINE FEED, it stops reading characters and sets the direction bits and the print bit in the status register. This action evokes the OUTPUT ROUTINE. A detailed flowchart of the INPUT ROUTINE is shown in Figure 4.1.

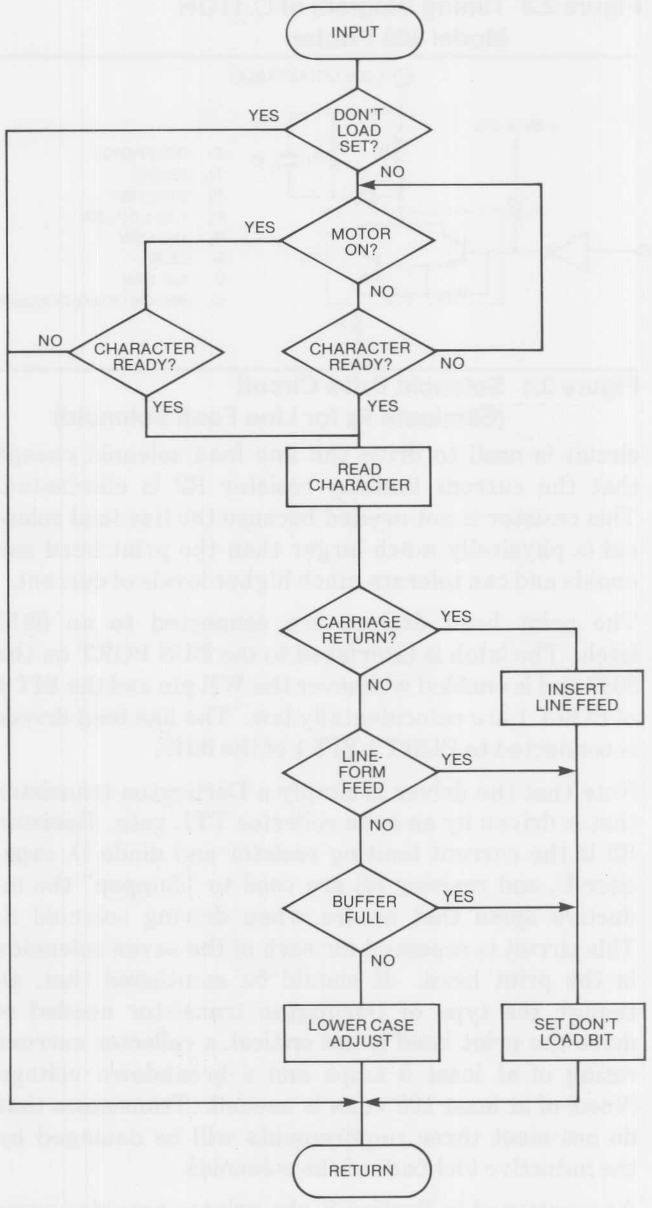


Figure 4.1 Input Routine Flowchart

The OUTPUT ROUTINE initializes both the input and output buffer pointers and then reads the characters from the 8049's buffer memory. After a character is read the OUTPUT ROUTINE calls the LOOKUP ROUTINE which reads the proper bit pattern to form that character. This bit pattern is then used to strobe the solenoids. After each character is printed, the OUTPUT ROUTINE calls the INPUT ROUTINE and another character is placed into the buffer memory. This type of operation guarantees that the input buffer cannot "overrun" the output buffer. A flowchart of the OUTPUT ROUTINE is shown in Figure 4.2.

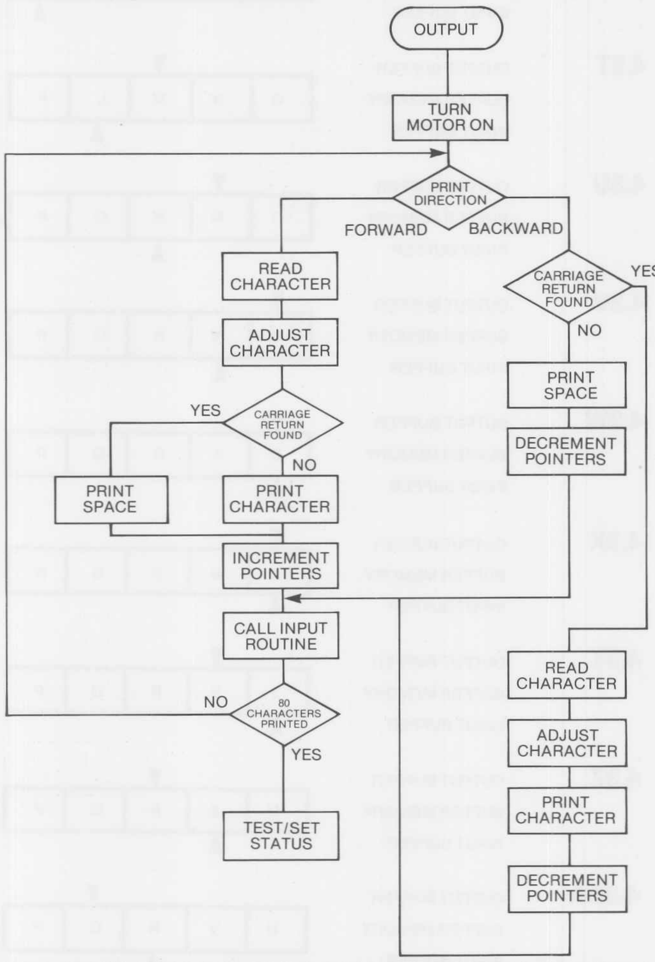


Figure 4.2 Output Routine Flowchart

IV-I. HANDLING THE I/O BUFFER

Since the C. ITOH Model 820 printer is capable of printing in both directions the 80 character buffer must be manipulated in a manner as to allow maximum input-output efficiency. This is accomplished by reversing the "direction" of the buffer memory each time the printer is printing from right to left. For simplicity, if it is assumed that the buffer is only five bytes long, Figure 4.3 can be used to help explain the buffer operation.

Initially the input buffer pointer is loaded with the address of the first location in the buffer memory. As characters are read, the input buffer pointer increments and fills the buffer memory as shown in Figure 4.3(b) through 4.3(f). When a CARRIAGE RETURN-LINE FEED (CRLF) is encountered the input buffer pointer and the output buffer pointer are reset back to the first location. The OUTPUT ROUTINE then reads the character from the first location in the buffer memory, increments the output buffer pointer and calls the INPUT ROUTINE, which reads another character from the parallel input port.

The OUTPUT ROUTINE reads the entire buffer, inserting space codes (20H) after a CR is detected, and the input buffer pointer follows the output buffer pointer as they "increment" up to the buffer memory. When the OUTPUT ROUTINE has printed the last character or space, the output buffer pointer and the input buffer pointer are set to point at the last location of the buffer memory. The OUTPUT ROUTINE then reads the character from the last location of the buffer memory and proceeds to "decrement" down the buffer memory. Space codes are inserted until a CR is found. Figure 4.3(1) to 4.3(0).

The input buffer pointer follows the output buffer pointer just as in the previous case. When the last, or in this case the first character is printed, the output buffer pointer and the input buffer pointer are set to point at the last location of the buffer memory. Now the pointers are "decrementing" down the buffer memory, but the printer is actually printing in a "normal" left to right fashion.

When the last character or space is printed, the output buffer and the input buffer pointer are set to the first location of the buffer memory and printing takes place in a reverse or right to left manner. After this line is printed, the print head and both buffer pointers are in the same position as they were initially. So, four lines must be printed before the buffer pointers and the print head complete a cycle. Each of these situations is handled separately by four different subroutines: CASE0, CASE1, CASE2, and CASE3.

IV-II. TIMING

All critical timing for the printer controller came from two basic sources; the timing sensors on the printer and the internal eight-bit timer of the 8049.

The internal timer of the 8049 was used to control the length of time the solenoids were fired (600 microseconds) and was also used as a "one-shot" to align the printer. This alignment is needed to make the "backward" printing line up vertically with the normal or forward printing. The "one-shot" is used to measure the time from the last column of the last character position until the right sensor flag is covered.

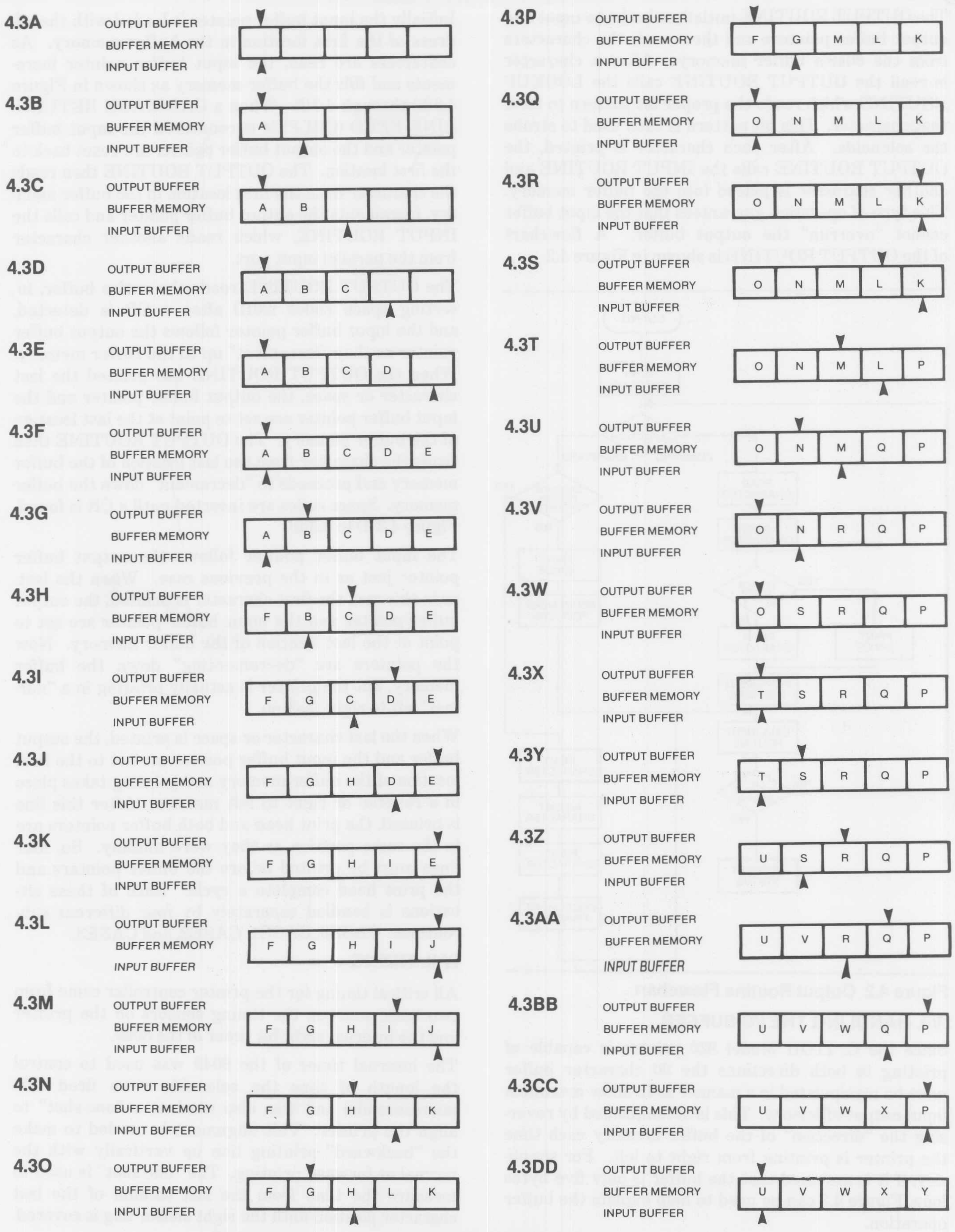


Figure 4.3 I/O Buffer Handler

When the print head reverses direction and the right sensor flag is uncovered, the timer is then used to determine where to start printing in the reverse direction.

The timer and the print wheel on the printer are used to determine when to place a character. The strobe from the print wheel informs the 8049 when to fire the solenoids and the timer allows the proper spacing between the characters.

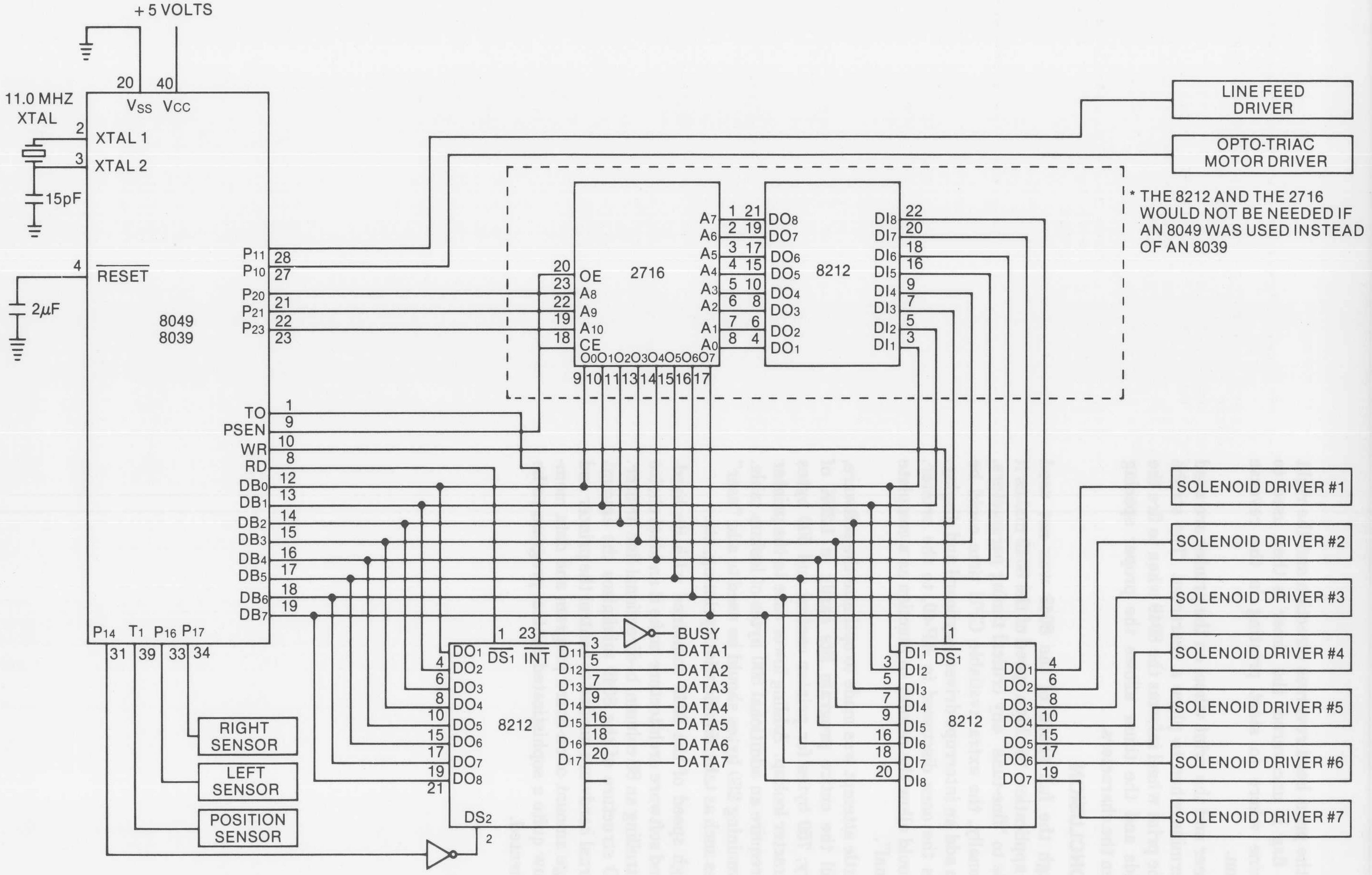
V. CONCLUSION

Although the full speed of the 8049 was not used in this application, the high speed of the 8049 makes it possible to "fine-tune" any critical timing parameters. Additionally, the extra available CPU time could be used to add an interrupt driven keyboard and display, such as the ones discussed in AP-40, to the printer. This would allow the printer to function as a complete "terminal".

Very little attempt was made to optimize the software, but still the entire program fits easily in 1.25K of memory; 750 bytes for printer control and 500 bytes for character lookup. Adding lower case to the printer would require an additional 500 bytes of lookup table. The remaining 250 bytes should be used to add "user" features such as tabs, double width printing, etc.

The high speed of the 8049 combined with its hardware and software architecture make it an ideal choice for controlling an 80 column, bi-directional line printer. The I/O structure of the 8049 minimizes the amount of external hardware needed to control the printer and the large amount of on-board program and data memory allow quite a sophisticated control program to be implemented.

APPENDIX A. SCHEMATIC DIAGRAM



APPENDIX B. MONITOR LISTING

```
LOC  OBJ         SEQ         SOURCE STATEMENT

                   1         ;
                   2         ;*****************************************************************
                   3         ;
                   4         ;THIS PROGRAM IMPLEMENTS CONTROL OF THE C.ITOH MODEL 820
                   5         ;PRINTER. THE HARDWARE CONFIGURATION IS AS SUCH:
                   6         ;8212 INPUT PORT ON BUS = DATA INPUT
                   7         ;8212 OUTPUT PORT ON BUS = OUTPUT TO SOLENOID HAMMERS
                   8         ;T1 INPUT = CHARACTER POSITIONING SENSOR ON PRINTER
                   9         ;T0 INPUT = INTERRUPT FROM 8212 INPUT PORT
                  10         ;PORT 10 = MOTOR ON, LOW = ON
                  11         ;PORT 11 = LINE FEED STROBE, LOW = ON
                  12         ;PORT 16 = LEFT MARGIN SENSOR, LOW WHEN COVERED, HIGH WHEN OPEN
                  13         ;PORT17 = RIGHT MARGIN SENSOR, LOW WHEN COVERED, HIGH WHEN OPEN
                  14         ;T1 = PIN 2 OF LM339, PRINT WHEEL SENSOR
                  15         ;PORT 16 = PIN 13 OF LM339
                  16         ;PORT 17 = PIN 14 OF LM339
                  17         ;
                  18         ;*****************************************************************
                  19         ;
                  20         ;SYSTEM EQUATES
                  21         ;
0000              22 INBUF    EQU     R0                ;POINTS AT INPUT LOCATION
0001              23 OUTBUF   EQU     R1                ;POINTS AT OUTPUT LOCATION
0002              24 SAVPNT   EQU     R2                ;STATUS FOR PRINTING
0003              25 STBCNT   EQU     R3                ;STROBE COUNTER
0004              26 TEMP1    EQU     R4
0005              27 STATUS   EQU     R5                ;BIT 0 = LINE FEED SET
                  28                                   ;BIT 1 = PRINT
                  29                                   ;BIT 2 = CONTINUE
                  30                                   ;BIT 3 = CR FOUND
                  31                                   ;BIT 4 = LF FOUND
                  32                                   ;BIT 5 = LF FOUND IN PRINTING
                  33                                   ;BIT 6 = PRINT DIRECTION
                  34                                   ;0 = RIGHT TO LEFT
                  35                                   ;1 = LEFT TO RIGHT
                  36                                   ;BIT 7 = BUFFER LOAD DIRECTION
                  37                                   ;0 = FIRST TO MAX
                  38                                   ;1 = MAX TO FIRST
0006              39 LINCNT   EQU     R6                ;THE LINE COUNTER
0007              40 JUNK1    EQU     R7
006F              41 MAX      EQU     6FH               ;MAX BUFFER LOCATION
0020              42 FIRST    EQU     20H               ;BOTTOM OF BUFFER
                  43 $EJECT
```

```
LOC   OBJ          SEQ        SOURCE STATEMENT

                    44         ;
0000                45         ORG      000H
                    46         ;
                    47         ;JUMP OVER THE INTERRUPT LOCATIONS
                    48         ;
0000 15             49         DIS      I              ;DON'T USE INTERRUPTS
0001 0400           50         JMP      BGIN           ;BEGIN THE PROGRAM
                    51         ;
000A                52         ORG      0AH
                    53         ;
                    54         ;START THE PROGRAM
                    55         ;
                    56         ;LOOP UNTIL THE BUFFER FILLS UP
                    57         ;
000A FD             58 PRNT:   MOV      A,STATUS       ;GET THE STATUS
000B 3211           59         JB1      LPRNT          ;IF PRINTING, CONTINUE
000D 3400           60         CALL     LDBUF          ;READ INTO THE BUFFER
000F 040A           61         JMP      PRNT           ;LOOP
                    62         ;
                    63         ;THIS ROUTINE PRINTS A LINE
                    64         ;IT FIRST SAVES THE STATUS
                    65         ;AND THEN DETERMINES WHICH DIRECTION TO PRINT
                    66         ;AND HOW TO MANIPULATE THE BUFFER
                    67         ;
0011 04C9           68 LPRNT:  JMP      STACHK          ;GO FIX UP THE STATUS
0013 F224           69 LPRNT1: JB7      CASE23          ;JUMP TO CASE 2 AND 3
0015 0417           70         JMP      CASE01          ;JUMP TO CASE 0 AND 1
                    71         ;
                    72         ;CASE01, LOADING THE BUFFER FROM FIRST TO MAX
                    73         ;
0017 B920           74 CASE01: MOV      OUTBUF,#FIRST   ;SET UP OUTBUF
0019 B820           75         MOV      INBUF,#FIRST    ;SET UP INBUF
001B FA             76         MOV      A,SAVPNT        ;GET THE SAVED STATUS
001C 94DC           77         CALL     MOTON           ;TURN ON THE MOTOR
001E D252           78         JB6      CASE1           ;PRINT FOWARD
0020 94B3           79         CALL     PRNTBK          ;GET READY TO PRINT BACKWARDS
0022 0431           80         JMP      CASE0           ;PRINT BACKWARDS
                    81         ;
                    82         ;CASE23, LOADING BUFFER FROM MAX TO FIRST
                    83         ;
0024 B96F           84 CASE23: MOV      OUTBUF,#MAX     ;SET UP OUTBUF
0026 B86F           85         MOV      INBUF,#MAX      ;SET UP INBUF
0028 FA             86         MOV      A,SAVPNT        ;GET THE PRINT STATUS
0029 94DC           87         CALL     MOTON           ;TURN ON THE MOTOR
002B D2C2           88         JB6      CASE3           ;PRINT LEFT TO RIGHT
002D 94B3           89         CALL     PRNTBK          ;GET READY TO PRINT BACKWARDS
002F 043D           90         JMP      CASE2           ;PRINT RIGHT TO LEFT
                    91         ;
                    92 $EJECT
```

```
LOC  OBJ         SEQ        SOURCE STATEMENT

0031 F1           93 CASE0:  MOV    A,@OUTBUF        ;GET THE CHARACTER
0032 3491         94         CALL   FXPRNT           ;ADJUST FOR PRINTING
0034 B120         95         MOV    @OUTBUF,#20H     ;PUT A SPACE IN BUFFER RAM
0036 F242         96         JB7    FDC              ;FOUND A CR
0038 945E         97         CALL   INCTST           ;UPDATE OUTBUF
003A C6AE         98         JZ     WATCHD           ;WAIT FOR END
003C BF20         99         MOV    JUNK1,#20H       ;GET A SPACE TO PRINT
003E 9463        100         CALL   GTPRNT           ;GO PRINT A SPACE
0040 0431        101         JMP    CASE0            ;LOOP
0042 BF20        102 FDC:    MOV    JUNK1,#20H       ;GO PRINT THE LAST SPACE
0044 9463        103 FDC1:   CALL   GTPRNT           ;GO PRINT A CHARACTER
0046 945E        104         CALL   INCTST           ;CHECK OUT BUFFER
0048 C6AE        105         JZ     WATCHD           ;WAIT FOR THE END
004A F1          106         MOV    A,@OUTBUF        ;GET THE CHARACTER
004B B120        107         MOV    @OUTBUF,#20H     ;PUT A SPACE THERE
004D 3491        108         CALL   FXPRNT           ;FIX THE CHARACTER UP
004F AF          109         MOV    JUNK1,A          ;SAVE IT
0050 0444        110         JMP    FDC1             ;LOOP
                 111         ;
                 112         ;
                 113         ;CASE 1, PRINTING LEFT TO RIGHT, LOADING BUFFER FROM
                 114         ;FIRST TO MAX
                 115         ;
0052 F1          116 CASE1:  MOV    A,@OUTBUF        ;GET THE CHARACTER
0053 3491        117         CALL   FXPRNT           ;ADJUST FOR PRINTING
0055 AF          118         MOV    JUNK1,A          ;SAVE ACC
0056 B120        119         MOV    @OUTBUF,#20H     ;PUT A SPACE IN THE BUFFER
0058 F262        120         JB7    CRFOND           ;FOUND A CR?
005A 9463        121         CALL   GTPRNT           ;GO PRINT THE CHARACTER
005C 945E        122         CALL   INCTST           ;CHECK THE BUFFER
005E C675        123         JZ     WATCH            ;IS THE LAST CHARACTER BEING PRINTED?
0060 0452        124         JMP    CASE1            ;LOOP
0062 B120        125 CRFOND: MOV    @OUTBUF,#20H     ;PUT A SPACE IN THE BUFFER MEMORY
0064 BF20        126         MOV    JUNK1,#20H       ;PUT A SPACE IN TEMP LOCATION
0066 9463        127         CALL   GTPRNT           ;GO PRINT THE SPACE
0068 945E        128         CALL   INCTST           ;CHECK THE BUFFER
006A C675        129         JZ     WATCH            ;LAST CHARACTER PRINTED?
006C F1          130         MOV    A,@OUTBUF        ;GET THE NEXT CHARACTER
006D 3491        131         CALL   FXPRNT           ;ADJUST IT
006F 0462        132         JMP    CRFOND           ;LOOP
                 133 $EJECT
```

```
LOC  OBJ         SEQ        SOURCE STATEMENT

                 134   ;
                 135   ;THIS ROUTINE CALLS THE LINE FEED
                 136   ;
0071 9478        137 DOLF:   CALL      LINEFD          ;STROBE LINE FEED SOLENOID
0073 840A        138         JMP       PRNT            ;GO BACK TO THE PRINT ROUTINE
                 139   ;
                 140   ;THIS ROUTINE COMPLETES A LINE WHEN THE PRINT
                 141   ;HEAD IS MOVING LEFT TO RIGHT
                 142   ;
0075 27          143 WATCH:  CLR       A               ;ZERO ACC
0076 62          144         MOV       T,A             ;ZERO TIMER
0077 55          145         STRT      T               ;START THE TIMER
0078 3400        146         CALL      LDBUF           ;GO READ THE LAST CHARACTER
007A 09          147 LOOPW:  IN        A,P1            ;EXAMIN PORT ONE
007B F27A        148         JB7       LOOPW           ;CHECK RIGHT HAND SENSOR
007D 65          149         STOP      TCNT            ;STOP THE TIMER
007E FD          150         MOV        A,STATUS       ;GET THE STATUS
007F 5285        151         JB2        OVR1           ;JUMP IF CONTINUE IS SET
0081 94DF        152         CALL       MOTOF          ;TURN MOTOR OFF
0083 53FD        153         ANL        A,#0FDH        ;RESET BIT ONE
0085 53FB        154 OVR1:   ANL        A,#0FBH        ;RESET CONTINUE BIT
0087 AD          155         MOV        STATUS,A       ;RESTORE STATUS
0088 FA          156         MOV        A,SAVPNT       ;GET THE SAVED STATUS
0089 B271        157         JB5        DOLF           ;DO A LINE FEED IF BIT IS SET
008B 840A        158         JMP        PRNT           ;GO BACK TO PRINT ROUTINE
                 159   ;
                 160   ;
                 161   ;CASE 2, PRINTING RIGHT TO LEFT, LOADING BUFFER FROM
                 162   ;MAX TO FIRST
                 163   ;
                 164   ;
008D F1          165 CASE2:  MOV        A,@OUTBUF      ;GET THE CHARACTER
008E 3491        166         CALL       FXPRNT         ;ADJUST FOR PRINTING
0090 B120        167         MOV        @OUTBUF,#20H   ;PUT A SPACE IN BUFFER RAM
0092 F29E        168         JB7        FDCR           ;FIND A CR YET
0094 9472        169         CALL       DECTST         ;CHECK THE BUFFER
0096 C6AE        170         JZ         WATCHD         ;IF ZERO WAIT FOR SENSOR FLAG
0098 BF20        171         MOV        JUNK1,#20H     ;PUT SPACE IN TEMP LOCATION
009A 9463        172         CALL       GTPRNT         ;GO PRINT SPACE
009C 048D        173         JMP        CASE2          ;LOOP
009E BF20        174 FDCR:   MOV        JUNK1,#20H     ;GET A SPACE
00A0 9463        175 FDCR1:  CALL       GTPRNT         ;GO PRINT THE CHARACTER
00A2 9472        176         CALL       DECTST         ;CHECK THE BUFFER
00A4 C6AE        177         JZ         WATCHD         ;LEAVE IF DONE
00A6 F1          178         MOV        A,@OUTBUF      ;GET A CHARACTER
00A7 3491        179         CALL       FXPRNT         ;ADJUST THE CHARACTER FOR PRINTING
00A9 AF          180         MOV        JUNK1,A        ;SAVE IT
00AA B120        181         MOV        @OUTBUF,#20H   ;PUT A SPACE WHERE THE CHARACTER WAS
00AC 04A0        182         JMP        FDCR1          ;LOOP
                 183 $EJECT
```

```
LOC  OBJ         SEQ        SOURCE STATEMENT

                 184        ;
                 185        ;THIS ROUTINE WAITS FOR THE SENSOR FLAGS TO BE COVERED
                 186        ;WHEN PRINTING RIGHT TO LEFT
                 187        ;
00AE 3400        188 WATCHD: CALL    LDBUF          ;GO READ THE LAST CHARACTER
00B0 09          189         IN      A,P1           ;GET SENSOR INFORMATION
00B1 D2AE        190         JB6     WATCHD         ;LOOP IF SENSOR IS NOT COVERED
00B3 FD          191         MOV     A,STATUS       ;GET THE STATUS
00B4 52BA        192         JB2     OVR            ;SEE IF CONTINUE IS SET
00B6 94DF        193         CALL    MOTOF          ;TURN THE MOTOR OFF
00B8 53FD        194         ANL     A,#0FDH        ;RESET BIT 1
00BA 53FB        195 OVR:    ANL     A,#0FBH        ;RESET BIT 3
00BC AD          196         MOV     STATUS,A       ;RESTORE STATUS
00BD FA          197         MOV     A,SAVPNT       ;GET THE SAVED STATUS
00BE B271        198         JB5     DOLF           ;DO A LINE FEED
00C0 040A        199         JMP     PRNT           ;EXIT
                 200        ;
                 201        ;CASE 3, PRINTING LEFT TO RIGHT, LOADING BUFFER FROM
                 202        ;MAK TO FIRST
                 203        ;
00C2 F1          204 CASE3:  MOV     A,@OUTBUF      ;GET A CHARACTER
00C3 3491        205         CALL    FXPRNT         ;FIX FOR PRINTING
00C5 AF          206         MOV     JUNK1,A        ;SAVE CHARACTER
00C6 B120        207         MOV     @OUTBUF,#20H   ;PUT A SPACE IN THE BUFFER
00C8 F2D2        208         JB7     CRFND          ;LEAVE IF A CR IS FOUND
00CA 9463        209         CALL    GTPRNT         ;GO PRINT THE CHARACTER
00CC 9472        210         CALL    DECTST         ;CHECK THE BUFFER
00CE C675        211         JZ      WATCH          ;LEAVE IF DONE
00D0 04C2        212         JMP     CASE3          ;LOOP
00D2 B120        213 CRFND:  MOV     @OUTBUF,#20H   ;PUT A SPACE IN THE BUFFER RAM
00D4 BF20        214         MOV     JUNK1,#20H     ;GET A SPACE
00D6 9463        215         CALL    GTPRNT         ;PRINT A SPACE
00D8 9472        216         CALL    DECTST         ;CHECK THE BUFFER
00DA C675        217         JZ      WATCH          ;LEAVE IF DONE
00DC F1          218         MOV     A,@OUTBUF      ;GET NEXT CHARACTER
00DD 3491        219         CALL    FXPRNT         ;ADJUST IT
00DF 04D2        220         JMP     CRFND          ;LOOP
                 221 $EJECT
```

```
LOC  OBJ        SEQ        SOURCE STATEMENT

0100                       ORG     100H
                           ;
0100 09              LDBUF: IN     A,P1            ;READ PORT 1
0101 B21C                  JB5     LNMODE          ;BIT 5 = H = LINE MODE
0103 1207                  JB0     ARND            ;JUMP AROUND IF MOTOR IS ON
0105 8901                  ORL     P1,#01H         ;TURN THE MOTOR OFF
0107 920F            ARND: JB4     NOFF            ;NO FORM FEED
0109 FE                    MOV     A,LINCNT        ;GET THE LINE COUNTER
010A 4380                  ORL     A,#80H          ;SET MSB
010C AE                    MOV     LINCNT,A        ;RESTORE THE LINE COUNTER
010D 23FF                  MOV     A,#0FFH         ;SET ACC
010F 721A            NOFF: JB3     NOLF            ;JUMP IF NO LINE FEED
0111 9478                  CALL    LINEFD          ;GO DO A LF OR FF
0113 09            BUTLOP: IN      A,P1            ;READ THE PORT
0114 721A                  JB3     NOLF            ;WAIT FOR SWITCH TO BE RELEASED
0116 921A                  JB4     NOLF            ;WAIT FOR SWITCH TO BE RELEASED
0118 2413                  JMP     BUTLOP          ;LOOP
011A 2400            NOLF: JMP     LDBUF           ;LOOP
                           ;
                           ;FIRST SEE IF A CHARACTER IS PRESENT IN THE BUFFER
                           ;
011C 261F          LNMODE: JNT0    CHAR            ;IF CHARACTER PRESENT, READ IT
011E 83                    RET                     ;IF NOT, EXIT ROUTINE
                           ;
                           ;IF THERE IS A CHARACTER, READ IT
                           ;
011F FD              CHAR: MOV     A,STATUS        ;GET THE STATUS
0120 5249                  JB2     ARNDJP          ;IF CONTINUE IS SET, DON'T LOAD
0122 9249                  JB4     ARNDJP          ;IF LF IS SET, DON'T LOAD
0124 724A                  JB3     LFCRCK          ;WAS CR SET, SEE IF NEXT CHAR IS LF
0126 94D6                  CALL    GTCAR           ;GO READ A CHARACTER
0128 3461            GOOD: CALL    FXCHAR          ;MAKE SURE IT IS OK
012A A0                    MOV     @INBUF,A        ;SAVE CHARACTER IN BUFFER MEMORY
012B FD                    MOV     A,STATUS        ;GET THE STATUS
012C F239                  JB7     SUB1            ;IF BIT 7 IS SET DECREMENT BUFFER
012E 18                    INC     INBUF           ;UPDATE INBUF
012F 2370                  MOV     A,#MAX+1        ;GET TOP
0131 D8                    XRL     A,INBUF         ;ARE WE AT THE TOP?
0132 9649                  JNZ     ARNDJP          ;IF NOT GET THE STATUS
0134 F8                    MOV     A,INBUF         ;GET INBUF
0135 07                    DEC     A               ;CHANGE BY ONE
0136 A8                    MOV     INBUF,A         ;PUT IT BACK
0137 2449                  JMP     ARNDJP          ;GET THE STATUS
0139 F8              SUB1: MOV     A,INBUF         ;GET INBUF
013A 07                    DEC     A               ;CHANGE BY ONE
013B A8                    MOV     INBUF,A         ;PUT INBUF BACK
013C 231F                  MOV     A,#FIRST-1      ;GET THE BOTTOM OF THE BUFFER
013E D8                    XRL     A,INBUF         ;TEST THE BUFFER
013F 9649                  JNZ     ARNDJP          ;IF NOT ZERO READ THE STATUS
0141 18                    INC     INBUF           ;MOVE INBUF BACK
0142 2449                  JMP     ARNDJP          ;GO GET STATUS
0144 FD            GETSTA: MOV     A,STATUS        ;GET THE STATUS
0145 1249                  JB0     ARNDJP          ;IF BIT 0 SET, BYPASS
0147 9250                  JB4     STBIT1          ;IF LF IS FOUND, SET THE STATUS
0149 83            ARNDJP: RET                     ;EXIT
                           ;
                           ;THIS ROUTINE "FORCES" A LF AFTER A CR
                           ;
014A 94D6          LFCRCK: CALL    GTCAR           ;READ A CHARACTER
014C 230A                  MOV     A,#0AH          ;GET A LINE FEED
014E 2428                  JMP     GOOD            ;JUMP BACK
                           ;
                           ;THIS ROUTINE SETS THE STATUS BITS
                           ;
0150 FD            STBIT1: MOV     A,STATUS        ;LOAD THE STATUS
0151 3259                  JB1     STPRNT          ;IF STILL PRINTING, LEAVE
0153 4302                  ORL     A,#02H          ;SET PRINT BIT
0155 0340                  ADD     A,#40H          ;UPDATE POSITION COUNTER
0157 AD                    MOV     STATUS,A        ;PUT STATUS BACK
0158 83                    RET                     ;EXIT ROUTINE
0159 5260          STPRNT: JB2     BYEBYE          ;CHECK CONTINUE BIT
015B 4304                  ORL     A,#04H          ;SET CONTINUE BIT
015D 0340                  ADD     A,#40H          ;UPDATE PRINT DIRECTION
015F AD                    MOV     STATUS,A        ;PUT THE STATUS BACK
0160 83            BYEBYE: RET                     ;EXIT
                           ;
```

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LOC  OBJ          SEQ        SOURCE STATEMENT

                  298        ;THIS ROUTINE "CONVERTS" LOWER CASE LETTERS TO
                  299        ;UPPER CASE
                  300        ;
0161 97           301 FKCHAR: CLR     C              ;CLEAR THE CARRY
0162 537F         302         ANL     A,#7FH         ;STRIP MSB
0164 AF           303         MOV     JUNK1,A        ;SAVE ACC
0165 03A0         304         ADD     A,#0A0H        ;SEE IF NUMBER IS 60H
0167 E670         305         JNC     FINE           ;IF CARRY ISN'T SET, JUMP
0169 FF           306         MOV     A,JUNK1        ;GET ACC BACK
016A 37           307         CPL     A              ;SUBTRACT 20H FROM THE ACC
016B 0320         308         ADD     A,#20H
016D 37           309         CPL     A
016E 2474         310         JMP     FIXDUN         ;JUMP TO TEST CR LF
0170 37           311 FINE:   CPL     A              ;NOW SUBTRACT A0H FROM ACC
0171 03A0         312         ADD     A,#0A0H
0173 37           313         CPL     A
0174 AF           314 FIXDUN: MOV     JUNK1,A        ;SAVE A
0175 D30D         315         XRL     A,#0DH         ;IS CHARACTER A CR
0177 967F         316         JNZ     LFTEST         ;IF IT IS NOT TEST LF
0179 FD           317         MOV     A,STATUS       ;GET THE STATUS
017A 4308         318         ORL     A,#08H         ;SET BIT 3
017C AD           319         MOV     STATUS,A       ;RESTORE THE STATUS
017D 248F         320         JMP     FIXFIN         ;LEAVE
017F FF           321 LFTEST: MOV     A,JUNK1        ;GET CHARACTER BACK
0180 D30A         322         XRL     A,#0AH         ;IS IT A LF
0182 C689         323         JZ      FIXUP          ;IF ITS NOT, WE ARE DONE
0184 FF           324         MOV     A,JUNK1        ;GET THE CHARACTER BACK
0185 D30C         325         XRL     A,#0CH         ;IS IT A FORM FEED
0187 968F         326         JNZ     FIXFIN         ;IF NOT FORM FEED, JUMP
0189 FD           327 FIXUP:  MOV     A,STATUS       ;GET THE STATUS
018A 4310         328         ORL     A,#10H         ;SET BIT 4
018C AD           329         MOV     STATUS,A       ;RETURN THE STATUS
018D 3450         330         CALL    STBIT1         ;SET THE STATUS
018F FF           331 FIXFIN: MOV     A,JUNK1        ;GET THE CHARACTER
LOC  OBJ          SEQ        SOURCE STATEMENT

0190 83           332         RET                    ;EXIT FIXCHAR
                  333        ;
                  334        ;THIS ROUTINE RECOGNIZES A LF, FF, AND CR
                  335        ;DURING THE PRINT OPERATION
                  336        ;IT ALSO FORCES A SPACE IF A CHARACTER FOUND
                  337        ;IN THE BUFFER IS NOT IN THE LOOKUP TABLE
                  338        ;
0191 AF           339 FKPRNT: MOV     JUNK1,A        ;SAVE ACC
0192 D30C         340         XRL     A,#0CH         ;FORM FEED
0194 C6B2         341         JZ      FFFIX          ;GO SET FORM FEED
0196 FF           342         MOV     A,JUNK1        ;RESTORE CHARACTER
0197 D30D         343         XRL     A,#0DH         ;SEE IF IT IS A CR
0199 C6A8         344         JZ      CRFIX          ;LEAVE IF IT IS
019B FF           345         MOV     A,JUNK1        ;GET ACC BACK
019C D30A         346         XRL     A,#0AH         ;SEE IF IT IS A LF
019E C6AB         347         JZ      LFFIX          ;LEAVE IF IT IS
01A0 FF           348         MOV     A,JUNK1        ;GET CHARACTER BACK
01A1 53E0         349         ANL     A,#0E0H        ;SEE IF IT IS A CHARACTER
01A3 96BD         350         JNZ     ISCHAR         ;IF IT IS JUMP
01A5 2320         351         MOV     A,#20H         ;PUT A SPACE IN ACC
01A7 83           352         RET                    ;EXIT
01A8 4380         353 CRFIX:  ORL     A,#80H         ;SET BIT 7
01AA 83           354         RET                    ;EXIT
01AB FD           355 LFFIX:  MOV     A,STATUS       ;GET THE STATUS
01AC 4320         356         ORL     A,#20H         ;SET LF BIT IN STATUS
01AE AD           357         MOV     STATUS,A       ;PUT THE STATUS BACK
01AF 2320         358         MOV     A,#20H         ;GET A SPACE
01B1 83           359         RET                    ;EXIT
01B2 FD           360 FFFIX:  MOV     A,STATUS       ;GET THE STATUS
01B3 4320         361         ORL     A,#20H         ;SET LINE FEED BIT
01B5 AD           362         MOV     STATUS,A       ;PUT THE STATUS BACK
01B6 FE           363         MOV     A,LINCNT       ;GET THE LINE COUNT
01B7 4380         364         ORL     A,#80H         ;SET BIT 7
01B9 AE           365         MOV     LINCNT,A       ;PUT LINE COUNT BACK
01BA 2320         366         MOV     A,#20H         ;GET A SPACE
01BC 83           367         RET                    ;EXIT
01BD FF           368 ISCHAR: MOV     A,JUNK1        ;GET CHARACTER BACK
01BE 533F         369         ANL     A,#3FH         ;STRIP THE TWO MSB
01C0 83           370         RET                    ;EXIT
```

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LOC  OBJ        SEQ       SOURCE STATEMENT

                371       ;
                372       ;THIS ROUTINE PRINTS THE CHARACTER IN THE ACC
                373       ;
01C1 AC         374 PRNTIT: MOV    TEMP1,A          ;SAVE CHARACTER
01C2 E7         375       RL       A                ;MULTIPLY BY TWO
01C3 E7         376       RL       A                ;MULTIPLY BY FOUR
01C4 6C         377       ADD      A,TEMP1          ;ADD ONCE TO MULTIPLY BY 5
                378       ;
                379       ;NOW SEE WHAT PART OF THE LOOKUP TABLE TO USE
                380       ;
01C5 2C         381       XCH      A,TEMP1          ;PUT CHARACTER IN A, TARGET IN TEMP1
01C6 B2CA       382       JB5      SHORT            ;JUMP TO HIGH ADDRESS IF BIT 5 SET
01C8 44AB       383       JMP      PAGE1            ;GO TO FIRST PART OF LOOKUP TABLE
01CA 64AB       384 SHORT: JMP     PAGE2            ;GO TO SECOND PAGE OF LOOKUP TABLE
                385       ;
                386       ;THIS ROUTINE TRIGGERS THE SOLENOIDS FOR 600 MICROSECONDS
                387       ;AFTER WAITING FOR THE TRIGGER SIGNAL FROM THE PRINTER
                388       ;*
01CC AF         389 FIRE:  MOV     JUNK1,A          ;SAVE THE ACC
01CD FD         390       MOV      A,STATUS         ;GET THE STATUS
01CE D2D4       391       JB6      NT1              ;SEE IF FORWARD OR BACKWARDS
01D0 56D0       392 FIREX: JT1     FIREX            ;WAIT FOR T1
01D2 24D6       393       JMP      FIREY            ;LEAVE
01D4 46D4       394 NT1:   JNT1    NT1              ;LOOP
01D6 FF         395 FIREY: MOV     A,JUNK1          ;GET ACC BACK
01D7 90         396       MOVX     @R0,A            ;TRIGGER THE SOLENOID
                397       ;
                398       ;NOW KILL 600 MICROSECONDS
                399       ;
01D8 23F3       400       MOV      A,#0F3H          ;LOAD DELAY NUMBER
01DA 62         401       MOV      T,A              ;PUT IT IN TIMER
01DB 55         402       STRT     T                ;START THE TIMER
01DC 16E0       403 TSJTF: JTF     KTDUN            ;LOOP ON TIMER FLAG
01DE 24DC       404       JMP      TSJTF            ;
01E0 27         405 KTDUN: CLR     A                ;ZERO ACC
01E1 90         406       MOVX     @R0,A            ;TURN OFF SOLENOIDS
01E2 65         407       STOP     TCNT             ;STOP THE TIMER
01E3 83         408       RET                       ;EXIT FIRE ROUTINE
                409 $EJECT
```

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LOC  OBJ           SEQ        SOURCE STATEMENT

                    410         ;
                    411         ;*****************************************************************
                    412         ;
                    413         ;THIS IS THE LOOKUP TABLE. THE MSB IS NOT USED, THE MSB - 1
                    414         ;IS THE DOT THAT IS THE TOP OF ANY GIVEN CHARACTER AND THE
                    415         ;LSB IS THE DOT THAT IS THE BOTTOM OF ANY GIVEN CHARACTER
                    416         ;
                    417         ;*****************************************************************
                    418         ;
0200                419         ORG     200H
                    420         ;*
0200 3E             421 TABLE1: DB      3EH            ;  *****
0201 41             422         DB      41H            ; *     *
0202 5D             423         DB      5DH            ; * *** *
0203 59             424         DB      59H            ; * **  *
0204 4E             425         DB      4EH            ; *  ***
                    426
0205 7C             427         DB      7CH            ; *****
0206 12             428         DB      12H            ;   *  *
0207 11             429         DB      11H            ;   *   *
0208 12             430         DB      12H            ;   *  *
0209 7C             431         DB      7CH            ; *****
                    432
020A 7F             433         DB      7FH            ; *******
020B 49             434         DB      49H            ; *  *  *
020C 49             435         DB      49H            ; *  *  *
020D 49             436         DB      49H            ; *  *  *
020E 36             437         DB      36H            ;  ** **
                    438
020F 3E             439         DB      3EH            ;  *****
0210 41             440         DB      41H            ; *     *
0211 41             441         DB      41H            ; *     *
0212 41             442         DB      41H            ; *     *
0213 22             443         DB      22H            ;  *   *
                    444
0214 7F             445         DB      7FH            ; *******
0215 41             446         DB      41H            ; *     *
0216 41             447         DB      41H            ; *     *
0217 41             448         DB      41H            ; *     *
0218 3E             449         DB      3EH            ;  *****
                    450
0219 7F             451         DB      7FH            ; *******
021A 49             452         DB      49H            ; *  *  *
021B 49             453         DB      49H            ; *  *  *
021C 49             454         DB      49H            ; *  *  *
021D 41             455         DB      41H            ; *     *
                    456 $EJECT
```

```
LOC  OBJ          SEQ          SOURCE STATEMENT

                   457
021E 7F            458          DB        7FH          ; *******
021F 09            459          DB        09H          ;    *  *
0220 09            460          DB        09H          ;    *  *
0221 09            461          DB        09H          ;    *  *
0222 01            462          DB        01H          ;       *
                   463
0223 3E            464          DB        3EH          ;  *****
0224 41            465          DB        41H          ; *     *
0225 41            466          DB        41H          ; *     *
0226 51            467          DB        51H          ; * *   *
0227 71            468          DB        71H          ; ***   *
                   469
0228 7F            470          DB        7FH          ; *******
0229 08            471          DB        08H          ;    *
022A 08            472          DB        08H          ;    *
022B 08            473          DB        08H          ;    *
022C 7F            474          DB        7FH          ; *******
                   475
022D 00            476          DB        00H          ;
022E 41            477          DB        41H          ; *     *
022F 7F            478          DB        7FH          ; *******
0230 41            479          DB        41H          ; *     *
0231 00            480          DB        00H          ;
                   481
0232 20            482          DB        20H          ;  *
0233 40            483          DB        40H          ; *
0234 40            484          DB        40H          ; *
0235 40            485          DB        40H          ; *
0236 3F            486          DB        3FH          ;  ******
                   487
0237 7F            488          DB        7FH          ; *******
0238 08            489          DB        08H          ;    *
0239 14            490          DB        14H          ;   * *
023A 22            491          DB        22H          ;  *   *
023B 41            492          DB        41H          ; *     *
                   493
023C 7F            494          DB        7FH          ; *******
023D 40            495          DB        40H          ; *
023E 40            496          DB        40H          ; *
023F 40            497          DB        40H          ; *
0240 40            498          DB        40H          ; *
                   499
0241 7F            500          DB        7FH          ; *******
0242 02            501          DB        02H          ;      *
0243 0C            502          DB        0CH          ;    **
0244 02            503          DB        02H          ;      *
0245 7F            504          DB        7FH          ; *******
                   505
0246 7F            506          DB        7FH          ; *******
0247 04            507          DB        04H          ;     *
0248 08            508          DB        08H          ;    *
0249 10            509          DB        10H          ;   *
024A 7F            510          DB        7FH          ; *******
                   511 $EJECT
```

```
LOC  OBJ          SEQ      SOURCE STATEMENT

                  512
0248 3E           513       DB      3EH        ;  *****
024C 41           514       DB      41H        ; *     *
024D 41           515       DB      41H        ; *     *
024E 41           516       DB      41H        ; *     *
024F 3E           517       DB      3EH        ;  *****
                  518
0250 7F           519       DB      7FH        ; *******
0251 09           520       DB      09H        ;    *  *
0252 09           521       DB      09H        ;    *  *
0253 09           522       DB      09H        ;    *  *
0254 06           523       DB      06H        ;     **
                  524
0255 3E           525       DB      3EH        ;  *****
0256 41           526       DB      41H        ; *     *
0257 51           527       DB      51H        ; * *   *
0258 21           528       DB      21H        ;  *    *
0259 5E           529       DB      5EH        ; * ****
                  530
025A 7F           531       DB      7FH        ; *******
025B 09           532       DB      09H        ;    *  *
025C 19           533       DB      19H        ;   **  *
025D 29           534       DB      29H        ;  * *  *
025E 46           535       DB      46H        ; *   **
                  536
025F 26           537       DB      26H        ;  *  **
0260 49           538       DB      49H        ; *  *  *
0261 49           539       DB      49H        ; *  *  *
0262 49           540       DB      49H        ; *  *  *
0263 32           541       DB      32H        ;  **  *
                  542
0264 01           543       DB      01H        ;       *
0265 01           544       DB      01H        ;       *
0266 7F           545       DB      7FH        ; *******
0267 01           546       DB      01H        ;       *
0268 01           547       DB      01H        ;       *
                  548
0269 3F           549       DB      3FH        ;  ******
026A 40           550       DB      40H        ; *
026B 40           551       DB      40H        ; *
026C 40           552       DB      40H        ; *
026D 3F           553       DB      3FH        ;  ******
                  554
026E 1F           555       DB      1FH        ;   *****
026F 20           556       DB      20H        ;  *
0270 40           557       DB      40H        ; *
0271 20           558       DB      20H        ;  *
0272 1F           559       DB      1FH        ;   *****
                  560
0273 7F           561       DB      7FH        ; *******
0274 20           562       DB      20H        ;  *
0275 18           563       DB      18H        ;   **
0276 20           564       DB      20H        ;  *
0277 7F           565       DB      7FH        ; *******
                  566 $EJECT
```

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LOC  OBJ          SEQ         SOURCE STATEMENT


0278 63                       DB    63H      ; **   **
0279 14                       DB    14H      ;   * *
027A 08                       DB    08H      ;    *
027B 14                       DB    14H      ;   * *
027C 63                       DB    63H      ; **   **

027D 03                       DB    03H      ;      **
027E 04                       DB    04H      ;     *
027F 78                       DB    78H      ; ****
0280 04                       DB    04H      ;     *
0281 03                       DB    03H      ;      **

0282 61                       DB    61H      ; **    *
0283 51                       DB    51H      ; * *   *
0284 49                       DB    49H      ; *  *  *
0285 45                       DB    45H      ; *   * *
0286 43                       DB    43H      ; *    **

0287 7F                       DB    7FH      ; *******
0288 7F                       DB    7FH      ; *******
0289 41                       DB    41H      ; *     *
028A 41                       DB    41H      ; *     *
028B 41                       DB    41H      ; *     *

028C 02                       DB    02H      ;      *
028D 04                       DB    04H      ;     *
028E 08                       DB    08H      ;    *
028F 10                       DB    10H      ;   *
0290 20                       DB    20H      ;  *

0291 41                       DB    41H      ; *     *
0292 41                       DB    41H      ; *     *
0293 41                       DB    41H      ; *     *
0294 7F                       DB    7FH      ; *******
0295 7F                       DB    7FH      ; *******

0296 10                       DB    10H      ;   *
0297 08                       DB    08H      ;    *
0298 04                       DB    04H      ;     *
0299 08                       DB    08H      ;    *
029A 10                       DB    10H      ;   *

029B 40                       DB    40H      ; *
029C 40                       DB    40H      ; *
029D 40                       DB    40H      ; *
029E 40                       DB    40H      ; *
029F 40                       DB    40H      ; *
                  $EJECT
```

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LOC  OBJ        SEQ       SOURCE STATEMENT

                 616       ;
02A0 B000        617 PAGE1: MOV     STBCNT,#00H       ;ZERO STROBE COUNTER
02A2 FA          618        MOV     A,SAVPNT          ;GET DIRECTION
02A3 37          619        CPL     A                 ;FLIP BITS
02A4 D2B3        620        JB6     BAKWRD            ;IF BACKWARD JUMP OUT
02A6 FC          621 LKLO:  MOV     A,TEMP1           ;GET THE TARGET
02A7 A3          622        MOVP    A,@A              ;GET THE DATA
02A8 34CC        623        CALL    FIRE              ;STROBE THE SOLENOIDS
02AA 1C          624        INC     TEMP1             ;INCREMENT THE POINTER
02AB 1B          625        INC     STBCNT            ;INCREMENT THE STROBE COUNTER
02AC FB          626        MOV     A,STBCNT          ;GET THE STROBE COUNTER
02AD D305        627        XRL     A,#05H            ;IS IT FIVE
02AF 96A6        628        JNZ     LKLO              ;REPEAT IF NOT FIVE
02B1 84AE        629        JMP     SETTIM            ;GO BACK
02B3 FC          630 BAKWRD: MOV    A,TEMP1           ;GET THE TARGET
02B4 0304        631        ADD     A,#04H            ;COMPENSATE FOR GOING BACKWARDS
02B6 AC          632        MOV     TEMP1,A           ;SAVE IT
02B7 FC          633 LKLO1: MOV     A,TEMP1           ;GET THE TARGET
02B8 A3          634        MOVP    A,@A              ;GET THE DATA
02B9 34CC        635        CALL    FIRE              ;STROBE THE SOLENOIDS
02BB FC          636        MOV     A,TEMP1           ;GET TEMP1
02BC 07          637        DEC     A                 ;DECREASE BY ONE
02BD AC          638        MOV     TEMP1,A           ;PUT IT BACK
02BE 1B          639        INC     STBCNT            ;INCREMENT THE STROBE COUNTER
02BF FB          640        MOV     A,STBCNT          ;GET THE STROBE COUNTER
02C0 D305        641        XRL     A,#05H            ;IS IT FIVE
02C2 96B7        642        JNZ     LKLO1             ;REPEAT IF NOT FIVE
02C4 84AE        643        JMP     SETTIM            ;GO BACK, CHARACTER IS DONE
                 644 $EJECT
```

```
LOC  OBJ          SEQ       SOURCE STATEMENT

                            ;*
0300                        ORG      300H
                            ;*

0300 00                     DB       00H        ;
0301 00                     DB       00H        ;
0302 00                     DB       00H        ;
0303 00                     DB       00H        ;
0304 00                     DB       00H        ;

0305 00                     DB       00H        ;
0306 00                     DB       00H        ;
0307 5F                     DB       5FH        ; * *****
0308 00                     DB       00H        ;
0309 00                     DB       00H        ;

030A 00                     DB       00H        ;
030B 07                     DB       07H        ;     ***
030C 00                     DB       00H        ;
030D 07                     DB       07H        ;     ***
030E 00                     DB       00H        ;

030F 14                     DB       14H        ;   * *
0310 7F                     DB       7FH        ; *******
0311 14                     DB       14H        ;   * *
0312 7F                     DB       7FH        ; *******
0313 14                     DB       14H        ;   * *

0314 24                     DB       24H        ;  *  *
0315 2A                     DB       2AH        ;  * * *
0316 7F                     DB       7FH        ; *******
0317 2A                     DB       2AH        ;  * * *
0318 12                     DB       12H        ;   *  *

0319 23                     DB       23H        ;  *   **
031A 13                     DB       13H        ;   *  **
031B 08                     DB       08H        ;    *
031C 64                     DB       64H        ; **  *
031D 62                     DB       62H        ; **   *

031E 36                     DB       36H        ;  ** **
031F 49                     DB       49H        ; *  *  *
0320 56                     DB       56H        ; * * **
0321 20                     DB       20H        ;  *
0322 50                     DB       50H        ; * *
                        $EJECT
```

```
LOC  OBJ          SEQ          SOURCE STATEMENT

                  691
0323 00           692            DB        00H          ;
0324 00           693            DB        00H          ;
0325 07           694            DB        07H          ;     ***
0326 00           695            DB        00H          ;
0327 00           696            DB        00H          ;
                  697
0328 1C           698            DB        1CH          ;   ***
0329 22           699            DB        22H          ;  *   *
032A 41           700            DB        41H          ; *     *
032B 00           701            DB        00H          ;
032C 00           702            DB        00H          ;
                  703
032D 00           704            DB        00H          ;
032E 00           705            DB        00H          ;
032F 41           706            DB        41H          ; *     *
0330 22           707            DB        22H          ;  *   *
0331 1C           708            DB        1CH          ;   ***
                  709
0332 22           710            DB        22H          ;  *   *
0333 14           711            DB        14H          ;   * *
0334 7F           712            DB        7FH          ; *******
0335 14           713            DB        14H          ;   * *
0336 22           714            DB        22H          ;  *   *
                  715
0337 08           716            DB        08H          ;    *
0338 08           717            DB        08H          ;    *
0339 7F           718            DB        7FH          ; *******
033A 08           719            DB        08H          ;    *
033B 08           720            DB        08H          ;    *
                  721
033C 00           722            DB        00H          ;
033D 40           723            DB        40H          ; *
033E 30           724            DB        30H          ;  **
033F 00           725            DB        00H          ;
0340 00           726            DB        00H          ;
                  727
0341 08           728            DB        08H          ;    *
0342 08           729            DB        08H          ;    *
0343 08           730            DB        08H          ;    *
0344 08           731            DB        08H          ;    *
0345 08           732            DB        08H          ;    *
                  733
0346 00           734            DB        00H          ;
0347 00           735            DB        00H          ;
0348 40           736            DB        40H          ; *
0349 00           737            DB        00H          ;
034A 00           738            DB        00H          ;
                  739
034B 20           740            DB        20H          ;  *
034C 10           741            DB        10H          ;   *
034D 08           742            DB        08H          ;    *
034E 04           743            DB        04H          ;     *
034F 02           744            DB        02H          ;      *
                  745
0350 3E           746            DB        3EH          ;  *****
0351 51           747            DB        51H          ; * *   *
0352 49           748            DB        49H          ; *  *  *
0353 45           749            DB        45H          ; *   * *
0354 3E           750            DB        3EH          ;  *****
                  751
0355 00           752            DB        00H          ;
0356 42           753            DB        42H          ; *    *
0357 7F           754            DB        7FH          ; *******
0358 40           755            DB        40H          ; *
0359 00           756            DB        00H          ;
                  757
035A 62           758            DB        62H          ; **   *
035B 51           759            DB        51H          ; * *   *
035C 49           760            DB        49H          ; *  *  *
035D 49           761            DB        49H          ; *  *  *
035E 46           762            DB        46H          ; *   **
                  763
035F 21           764            DB        21H          ;  *    *
0360 41           765            DB        41H          ; *     *
```

```
LOC   OBJ          SEQ        SOURCE STATEMENT

0361  49           766          DB      49H         ; *  *  *
0362  4D           767          DB      4DH         ; *  ** *
0363  33           768          DB      33H         ;  **  **
                   769
0364  18           770          DB      18H         ;   **
0365  14           771          DB      14H         ;   * *
0366  12           772          DB      12H         ;   *  *
0367  7F           773          DB      7FH         ; *******
0368  10           774          DB      10H         ;   *
                   775
0369  27           776          DB      27H         ;  *  ***
036A  45           777          DB      45H         ; *   * *
036B  45           778          DB      45H         ; *   * *
036C  45           779          DB      45H         ; *   * *
036D  39           780          DB      39H         ;  ***  *
                   781
036E  3C           782          DB      3CH         ;  ****
036F  4A           783          DB      4AH         ; *  * *
0370  49           784          DB      49H         ; *  *  *
0371  49           785          DB      49H         ; *  *  *
0372  31           786          DB      31H         ;  **   *
                   787
0373  01           788          DB      01H         ;       *
0374  71           789          DB      71H         ; ***   *
0375  09           790          DB      09H         ;    *  *
0376  05           791          DB      05H         ;     * *
0377  03           792          DB      03H         ;      **
                   793
0378  36           794          DB      36H         ;  ** **
0379  49           795          DB      49H         ; *  *  *
037A  49           796          DB      49H         ; *  *  *
037B  49           797          DB      49H         ; *  *  *
037C  36           798          DB      36H         ;  ** **
                   799 $EJECT
```

```
LOC  OBJ          SEQ      SOURCE STATEMENT

                  800
037D 46           801        DB      46H          ; *   ** 
037E 49           802        DB      49H          ; *  *  *
037F 49           803        DB      49H          ; *  *  *
0380 29           804        DB      29H          ;  * *  *
0381 1E           805        DB      1EH          ;   **** 
                  806
0382 00           807        DB      00H          ;
0383 00           808        DB      00H          ;
0384 14           809        DB      14H          ;   * *
0385 00           810        DB      00H          ;
0386 00           811        DB      00H          ;
                  812
0387 00           813        DB      00H          ;
0388 40           814        DB      40H          ; *
0389 34           815        DB      34H          ;  ** *
038A 00           816        DB      00H          ;
038B 00           817        DB      00H          ;
                  818
038C 08           819        DB      08H          ;    *
038D 14           820        DB      14H          ;   * *
038E 22           821        DB      22H          ;  *   *
038F 41           822        DB      41H          ; *     *
0390 00           823        DB      00H          ;
                  824
0391 14           825        DB      14H          ;   * *
0392 14           826        DB      14H          ;   * *
0393 14           827        DB      14H          ;   * *
0394 14           828        DB      14H          ;   * *
0395 14           829        DB      14H          ;   * *
                  830
0396 00           831        DB      00H          ;
0397 41           832        DB      41H          ; *     *
0398 22           833        DB      22H          ;  *   *
0399 14           834        DB      14H          ;   * *
039A 08           835        DB      08H          ;    *
                  836
039B 02           837        DB      02H          ;      *
039C 01           838        DB      01H          ;       *
039D 59           839        DB      59H          ; * **  *
039E 05           840        DB      05H          ;     * *
039F 02           841        DB      02H          ;      *
                  842 $EJECT
```

```
LOC  OBJ         SEQ        SOURCE STATEMENT

03A0 BB00         843 PAGE2:  MOV    STBCNT,#00H      ;ZERO STROBE COUNTER
03A2 FA           844         MOV    A,SAVPNT         ;GET DIRECTION
03A3 37           845         CPL    A                ;FLIP BITS
03A4 D2B5         846         JB6    BKWRD            ;IF BACKWARD JUMP OUT
03A6 FC           847 LKHI:   MOV    A,TEMP1          ;GET THE TARGET
03A7 0360         848         ADD    A,#60H           ;ADJUST THE TARGET
03A9 A3           849         MOVP   A,@A             ;GET THE DATA
03AA 34CC         850         CALL   FIRE             ;STROBE THE SOLENOIDS
03AC 1C           851         INC    TEMP1            ;INCREMENT THE POINTER
03AD 1B           852         INC    STBCNT           ;INCREMENT THE STROBE COUNTER
03AE FB           853         MOV    A,STBCNT         ;GET THE STROBE COUNTER
03AF D305         854         XRL    A,#05H           ;IS IT FIVE
03B1 96A6         855         JNZ    LKHI             ;REPEAT IF NOT FIVE
03B3 84AE         856         JMP    SETTIM           ;GO BACK
03B5 FC           857 BKWRD:  MOV    A,TEMP1          ;GET THE TARGET
03B6 0364         858         ADD    A,#64H           ;COMPENSATE FOR GOING BACKWARDS
03B8 AC           859         MOV    TEMP1,A          ;SAVE IT
03B9 FC           860 LKHI1:  MOV    A,TEMP1          ;GET THE TARGET
03BA A3           861         MOVP   A,@A             ;GET THE DATA
03BB 34CC         862         CALL   FIRE             ;STROBE THE SOLENOIDS
03BD FC           863         MOV    A,TEMP1          ;GET TEMP1
03BE 07           864         DEC    A                ;DECREASE BY ONE
03BF AC           865         MOV    TEMP1,A          ;PUT IT BACK
03C0 1B           866         INC    STBCNT           ;INCREMENT THE STROBE COUNTER
03C1 FB           867         MOV    A,STBCNT         ;GET THE STROBE COUNTER
03C2 D305         868         XRL    A,#05H           ;IS IT FIVE
03C4 96B9         869         JNZ    LKHI1            ;REPEAT IF NOT FIVE
03C6 84AE         870         JMP    SETTIM           ;GO BACK, CHARACTER IS DONE
                  871 $EJECT
```

```
LOC  OBJ                SOURCE STATEMENT

                        ;
0400                    ORG     0400H
                        ;
0400 27          BGIN:  CLR     A                 ;ZERO ACC
0401 90                 MOVX    @R0,A             ;TURN OFF THE SOLENOIDS
0402 9408               CALL    SETUP             ;SET UP THE PRINTER
0404 943F               CALL    VARSET            ;SET UP THE SOFTWARE
0406 840A               JMP     PRNT              ;GO START
                        ;
0408 23FE        SETUP: MOV     A,#0FEH           ;LOAD ACC WITH VALUE TO TURN ON MOTOR
040A 39                 OUTL    P1,A              ;TURN ON MOTOR
                        ;
                        ;NOW DELAY 3.2 SECONDS WHILE CHECKING RIGHT SENSOR
                        ;
040B BC05               MOV     TEMP1,#05H        ;LOAD DELAY VALUE ONE
040D BFFF        SELFC: MOV     JUNK1,#0FFH       ;LOAD DELAY VALUE TWO
040F BEFF        SELFB: MOV     LINCNT,#0FFH      ;LOAD DELAY VALUE THREE
0411 09          SELFA: IN      A,P1              ;READ PORT ONE
0412 37                 CPL     A                 ;MAKE THINGS RIGHT
0413 F21D               JB7     DONER             ;IS BIT 7 SET?
0415 EE11               DJNZ    LINCNT,SELFA      ;SMALL LOOP
0417 EF0F               DJNZ    JUNK1,SELFB       ;BIGGER LOOP
0419 EC0D               DJNZ    TEMP1,SELFC       ;BIGGEST LOOP
041B 845A               JMP     ERROR             ;SOMETHING IS WRONG
                        ;
                        ;NOW MAKE SURE THE RIGHT SENSOR IS CLEARED
                        ;
041D BFFF        DONER: MOV     JUNK1,#0FFH       ;SET UP DELAY
041F BEFF        SELF:  MOV     LINCNT,#0FFH      ;SOME MORE DELAY
0421 09          SELF1: IN      A,P1              ;GET THE FLAG INFORMATION
0422 F22A               JB7     DONEF             ;IS FLAG CLEARED?
0424 EE21               DJNZ    LINCNT,SELF1      ;IF NOT LOOP
0426 EF1F               DJNZ    JUNK1,SELF        ;LOOP SOME MORE
0428 845A               JMP     ERROR             ;LEAVE IF FLAG IS NOT UNCOVERED
                        ;
                        ;NOW CHECK THE LEFT SENSOR IN THE SAME MANNER AS THE
                        ;RIGHT SENSOR, EXCEPT DELAY ONLY 2.5 SECONDS
                        ;
042A BC04        DONEF: MOV     TEMP1,#04H        ;LOAD DELAY 1
042C BFFF        SELFCC:MOV     JUNK1,#0FFH       ;LOAD DELAY 2
042E BEFF        SELFBB:MOV     LINCNT,#0FFH      ;LOAD DELAY 3
0430 09          SELFAA:IN      A,P1              ;READ THE PORT
0431 37                 CPL     A                 ;CHANGE THINGS AROUND
0432 D23C               JB6     DONEL             ;OK IF BIT 6 IS A ZERO
0434 EE30               DJNZ    LINCNT,SELFAA     ;SMALL LOOP
0436 EF2E               DJNZ    JUNK1,SELFBB      ;BIGGER LOOP
0438 EC2C               DJNZ    TEMP1,SELFCC      ;BIGGEST LOOP
043A 845A               JMP     ERROR             ;SOMETHING IS WRONG
043C 8901        DONEL: ORL     P1,#01H           ;TURN MOTOR OFF
043E 83                 RET                       ;GO BACK
                        ;
                        ;NOW SET UP THE VARIABLES
                        ;
043F 23FE        VARSET:MOV     A,#0FEH           ;LOAD THE TIMER
0441 62                 MOV     T,A
0442 55                 STRT    T                 ;START THE TIMER
0443 B820               MOV     INBUF,#FIRST      ;LOAD INPUT BUFFER
0445 BE00               MOV     LINCNT,#00H       ;SET LINE COUNT
0447 BD00               MOV     STATUS,#00H       ;SET FORWARD BIT
                        ;
                        ;NOW CLEAR THE RAM AREA BY WRITING SPACE CODES
                        ;
0449 B920               MOV     OUTBUF,#FIRST     ;LOAD OUTBUF
044B 2320        CLRMEM:MOV     A,#20H            ;PUT SPACE CODE IN ACC
044D A1                 MOV     @OUTBUF,A         ;PUT SPACE CODE IN DATA MEMORY
044E 19                 INC     OUTBUF            ;UPDATE THE POINTER
044F F9                 MOV     A,OUTBUF          ;MOVE THE POINTER INTA ACC
0450 D370               XRL     A,#MAK+1          ;SEE IF DONE
0452 964B               JNZ     CLRMEM            ;LOOP IF NOT CLEARED
                        ;
                        ;NOW CLEAR THE 8212
                        ;
0454 99EF               ANL     P1,#0EFH          ;SET ENABLE BIT
0456 80                 MOVX    A,@INBUF          ;CLEAR THE 8212 INPUT BUFFER
0457 8910               ORL     P1,#10H           ;RESET ENABLE BIT
                        ;
```

```
LOC  OBJ          SOURCE STATEMENT
                         ;NOW EXIT VARSET
                         ;
0459 83                  RET                        ;LEAVE INITIALIZATION
                         ;
                         ;THIS ROUTINE TURNS THE MOTOR OFF AND LOOPS
                         ;
045A 89FF        ERROR:  ORL     P1,#0FFH           ;TURN OFF MOTOR
045C 845C        DEAD:   JMP     DEAD               ;LOOP BECAUSE SOMETHING IS WRONG
                         ;
                         ;THESE ARE ALL SUBROUTINES THAT ARE CALLED
                         ;
045E 19          INCTST: INC     OUTBUF             ;UPDATE THE POINTER
045F 2370                MOV     A,#MAX+1           ;GET THE VALUE FOR THE LAST CHARACTER
0461 D9                  XRL     A,OUTBUF           ;DO THE TEST
0462 83                  RET                        ;EXIT
0463 09          GTPRNT: IN      A,P1               ;READ PORT ONE
0464 37                  CPL     A                  ;FLIP BITS
0465 D263                JB6     GTPRNT             ;LOOP UNTIL SENSOR IS UNCOVERED
0467 166B        TSTJTF: JTF     PIT                ;SEE IF TIMER FLAG IS SET
0469 8467                JMP     TSTJTF             ;TEST FLAG
046B 65          PIT:    STOP    TCNT               ;STOP THE TIMER
046C FF                  MOV     A,JUNK1            ;GET THE CHARACTER
046D 34C1                CALL    PRNTIT             ;PRINT THE CHARACTER
046F 341C                CALL    LNMODE             ;GET ANOTHER CHARACTER
0471 83                  RET                        ;EXIT
0472 F9          DECTST: MOV     A,OUTBUF           ;GET OUTBUF
0473 07                  DEC     A                  ;REDUCE BY ONE
0474 A9                  MOV     OUTBUF,A           ;PUT BACK IN OUTBUF
0475 D31F                XRL     A,#FIRST-1         ;SEE IF IT IS ALL THE WAY DOWN
0477 83                  RET                        ;EXIT
                         ;
                         ;THIS ROUTINE DOES A LINE FEED
                         ;
0478 FE          LINEFD: MOV     A,LINCNT           ;GET THE LINE COUNT
0479 F298                JB7     DOFF               ;IF BIT 7 IS SET, DO A FORMFEED
047B 99FD        LFDO:   ANL     P1,#0FDH           ;TURN ON THE SOLENOID
047D BC4D                MOV     TEMP1,#4DH         ;LOAD ONE DELAY
047F BF93        LFLP1:  MOV     JUNK1,#93H         ;LOAD ANOTHER DELAY
0481 EF81        LFLP2:  DJNZ    JUNK1,LFLP2        ;LOOP
0483 EC7F                DJNZ    TEMP1,LFLP1        ;LOOP SOME MORE
0485 8902                ORL     P1,#02H            ;TURN OFF LF SOLENOID
0487 1E                  INC     LINCNT             ;UPDATE THE LINE COUNTER
0488 FE                  MOV     A,LINCNT           ;GET THE LINE COUNT
0489 D328                XRL     A,#28H             ;IS PAGE DONE
048B 968F                JNZ     NOTDON             ;SKIP OVER
048D BE00                MOV     LINCNT,#00H        ;ZERO LINE COUNTER
                         ;
                         ;NOW DELAY 90 MILLISECONDS
                         ;
048F BC80        NOTDON: MOV     TEMP1,#80H         ;LOAD DELAY VALUES
0491 BFFF        LOP1:   MOV     JUNK1,#0FFH        ;
0493 EF93        LOP2:   DJNZ    JUNK1,LOP2         ;GENERATE DELAY
0495 EC91                DJNZ    TEMP1,LOP1
0497 83                  RET                        ;LINE FEED IS DONE
                         ;
                         ;THIS ROUTINE DOES A FORM FEED
                         ;
0498 09          DOFF:   IN      A,P1               ;GET THS STATUS
0499 37                  CPL     A                  ;FLIP ACC
049A 53C0                ANL     A,#0C0H            ;LEAVE ONLY TWO MSB'S
049C C698                JZ      DOFF               ;IF A FLAG ISN'T COVERED, LOOP
049E 8901                ORL     P1,#01H            ;TURN THE MOTOR OFF
04A0 947B                CALL    LFDO               ;GO DO ONE LINE FEED
04A2 FE          FFCK:   MOV     A,LINCNT           ;GET THE LINE COUNT
04A3 537F                ANL     A,#7FH             ;STRIP BIT SEVEN
04A5 D300                XRL     A,#00H             ;IS IT DONE
04A7 C6AD                JZ      FFDONE             ;LEAVE IF IT IS
04A9 947B                CALL    LFDO               ;STROBE THE SOLENOIDS
04AB 84A2                JMP     FFCK               ;CHECK THE FORM FEED OUT
04AD 83          FFDONE: RET                        ;EXIT FORM FEED
                         ;
04AE 23EB        SETTIM: MOV     A,#0EBH            ;GET DELAY VALUE
04B0 62                  MOV     T,A                ;PUT IN TIMER
04B1 55                  STRT    T                  ;START THE TIMER
04B2 83                  RET                        ;EXIT
                         ;
```

```
LOC  OBJ         SEQ          SOURCE STATEMENT

04B3 42          1024 PRNTBK: MOV     A,T              ;GET THE TIMER
04B4 37          1025         CPL     A                ;TWOS COMPLEMENT ACC
04B5 17          1026         INC     A
04B6 17          1027         INC     A
04B7 17          1028         INC     A
04B8 17          1029         INC     A
04B9 17          1030         INC     A                ;ADJUST TIMER
04BA 62          1031         MOV     T,A              ;PUT IT BACK IN THE TIMER
04BB 09          1032 INLOOP: IN      A,P1             ;READ PORT 1
04BC F2C0        1033         JB7     CONPBK           ;IF SENSOR IN NOT COVERED, LEAVE
04BE 84BB        1034         JMP     INLOOP           ;OTHERWISE LOOP
04C0 55          1035 CONPBK: STRT    T                ;START THE TIMER
04C1 16C5        1036 CONPB:  JTF     RDTOPT           ;SEE IF READY TO PRINT
04C3 84C1        1037         JMP     CONPB            ;OTHERWISE LOOP
04C5 23FF        1038 RDTOPT: MOV     A,#0FFH          ;LOAD A
04C7 62          1039         MOV     T,A              ;PUT IT IN THE TIMER
04C8 83          1040         RET                      ;EXIT
                 1041         ;
                 1042         ;THIS ROUTINE ADJUSTS AND SAVES THE STATUS DURING PRINTING
                 1043         ;
04C9 FD          1044 STACHK: MOV     A,STATUS         ;GET THE STATUS
04CA 92D2        1045         JB4     LFSET            ;SET LINE FEED BIT
04CC AA          1046 B4RET:  MOV     SAVPNT,A         ;SAVE THE STATUS
04CD 53C2        1047         ANL     A,#0C2H          ;RESET EVERYTHING EXCEPT
                 1048                                  ;DIRECTION AND PRINT
04CF AD          1049         MOV     STATUS,A         ;PUT THE STATUS BACK
04D0 0413        1050         JMP     LPRNT1           ;EXIT
04D2 4320        1051 LFSET:  ORL     A,#20H           ;SET BIT 5
04D4 84CC        1052         JMP     B4RET            ;JUMP BACK
                 1053         ;
                 1054         ;THIS ROUTINE READS A CHARACTER AND PUTS IT IN THE ACC
                 1055         ;
04D6 99EF        1056 GTCAR:  ANL     P1,#0EFH         ;SET ENABLE BIT
04D8 80          1057         MOVX    A,@INBUF         ;READ THE CHARACTER
04D9 8910        1058         ORL     P1,#10H          ;RESET ENABLE BIT
04DB 83          1059         RET                      ;EXIT GTCHAR
                 1060         ;
                 1061         ;THIS ROUTINE TURNS THE MOTOR ON
                 1062         ;
04DC 99FE        1063 MOTON:  ANL     P1,#0FEH         ;TURN MOTOR ON
04DE 83          1064         RET                      ;EXIT
                 1065         ;
                 1066         ;THIS ROUTINE TURNS THE MOTOR OFF
                 1067         ;
04DF 8901        1068 MOTOF:  ORL     P1,#01H          ;TURN MOTOR OFF
04E1 83          1069         RET                      ;EXIT
                 1070         ;
                 1071         END                      ;DONE

USER SYMBOLS
ARND   0107   ARNDJP 0149   B4RET  04CC   BAKWRD 02B3   BGIN   0400   BKWRD  03B5   BUTLOP 0113   BYEBYE 0160
CASE0  0031   CASE01 0017   CASE1  0052   CASE2  008D   CASE23 0024   CASE3  00C2   CHAR   011F   CLRMEM 044B
CONPB  04C1   CONPBK 04C0   CRFIX  01A8   CRFND  00D2   CRFOND 0062   DEAD   045C   DECTST 0472   DOFF   0498
DOLF   0071   DONEF  042A   DONEL  043C   DONER  041D   ERROR  045A   FDC    0042   FDC1   0044   FDCR   009E
FDCR1  00A0   FFCK   04A2   FFDONE 04AD   FFFIX  01B2   FINE   0170   FIRE   01CC   FIREX  01D0   FIREY  01D6
FIRST  0020   FIXDUN 0174   FIXFIN 018F   FIXUP  0189   FXCHAR 0161   FXPRNT 0191   GETSTA 0144   GOOD   0128
GTCAR  04D6   GTPRNT 0463   INBUF  0000   INCTST 045E   INLOOP 04BB   ISCHAR 01BD   JUNK1  0007   KTDUN  01E0
LDBUF  0100   LFCRCK 014A   LFDD   047B   LFFIX  01AB   LFLP1  047F   LFLP2  0481   LFSET  04D2   LFTEST 017F
LINCNT 0006   LINEFD 0478   LKHI   03A6   LKHI1  03B9   LKLO   02A6   LKLO1  02B7   LNMODE 011C   LOOPW  007A
LOP1   0491   LOP2   0493   LPRNT  0011   LPRNT1 0013   MAX    006F   MOTOF  04DF   MOTON  04DC   NOFF   010F
NOLF   011A   NOTDON 048F   NT1    01D4   OUTBUF 0001   OVR    000A   OVR1   0085   PAGE1  02A0   PAGE2  03A0
PIT    046B   PRNT   000A   PRNTBK 04B3   PRNTIT 01C1   RDTOPT 04C5   SAVPNT 0002   SELF   041F   SELF1  0421
SELFA  0411   SELFAA 0430   SELFB  040F   SELFBB 042E   SELFC  040D   SELFCC 042C   SETTIN 04AE   SETUP  0408
SHORT  01CA   STACHK 04C9   STATUS 0005   STBCNT 0003   STBIT1 0150   STPRNT 0159   SUB1   0139   TABLE1 0200
TEMP1  0004   TSJTF  01DC   TSTJTF 0467   VARSET 043F   WATCH  0075   WATCHD 00AE

ASSEMBLY COMPLETE,  NO ERRORS
```